

## **PRIOR ART STATEMENT**

Following is a discussion of the patents provided by search conducted by the Washington Patent Services Corporation for the Assignee of the subject invention.

### **4,487,034    Energy-Efficient All-Electric ECS for Aircraft**

The system described in this invention primarily using cold ram air to condense the refrigerant of the vapor cycle system. Then the system uses the vapor cycle to cool the outside ram air for cockpit pressurization. When the ram air temperature increases during high-speed flight, the vapor cycle system could not be cooled by direct ram air. Hence this system design is only for flight that has ram air of total temperature lower than approximately 140 degree F. The simple compressor that used to provide cockpit pressurization would consume very high power and could not help to transfer heat loads.

The uniqueness of the subject hybrid cooling system (HCS) is running the vapor cycle system in relatively high temperature and coupled with air cycle system to enable sinking heat into hot fuel heated by aero-thermal effects of high-speed flight. The interconnected feature of the HCS is unique and differs than '034 invention.

### **5,545,084    Method and Apparatus for Air Conditioning Two Passenger Decks of An Aircraft**

This invention addresses the distribution and control of a double deck aircraft cabin. There is no detail about the air conditioning system mentioned. The subject Hybrid Cooling System addresses cooling air generation using fuel as the primary heat sink. The uniqueness of the (HCS) is running the vapor cycle system at relatively high temperature and coupling air cycle system to enable sinking heat into hot fuel heated by aero-thermal effects of high-speed flight..

### **4,869,071    Cooling System for An Aircraft Pod**

This invention discloses a ram air-cooled vapor cycle system providing cooling to an electronic pod. The ram air temperature required to condense the refrigerant limits the capability of this system. For high-speed flight, the ram air temperature will be higher than the condensing temperature of the refrigerant required to provide the temperature range for electronics cooling. Thus, this system can only apply to sub-sonic flight application.

The uniqueness of the hybrid cooling system (HCS) is running the vapor cycle system at relatively high temperature and coupled with air cycle system to enable sinking heat into hot fuel heated by aero-thermal effects of high-speed flight. The HCS is also designed for overall air vehicle implementation.

**6,182,435 Thermal and Energy Management Method and Apparatus for An Aircraft**

This system represents the prior-art that the subject invention has improved upon. The electronics is cooled directly by fuel that, which not be feasible in the sustained high-speed flight where fuel is heated by aero-thermal effects. Fuel re-circulation is used to handle the load and sink imbalance. The subject invention avoids the fuel re-circulation by using high temperature fuel. The air temperature exiting from the air cycle system compressor is high and is designed to sink into the fuel that is fairly warm after picking up heat from the vapor cycle system and engine heat loads.

The uniqueness of the subject hybrid cooling system is that the vapor cycle system is running at relatively high temperature and is coupled with air cycle system to enable sinking heat into hot fuel heated by aero-thermal effects of high-speed flight.

**5,058,390 Aircraft Vapor Cycle Cooling System with Two Speed Control of a Condenser Fan and Method of Operation**

This invention describes a control scheme for a typical aircraft vapor cycle system. The main claim is in the control of the fan that cools the condenser. The uniqueness of the subject system (HCS) is running the vapor cycle system in relatively high temperature and coupled with the air cycle system to enable sinking heat into hot fuel heated by aero-thermal effects of high-speed flight.

**6,041,615 Air Cycle Air Conditioning System**

This invention describes a simple air cycle system using water injection to improve system efficiency. Using a turbine to suck in the ambient air and then expanded to generate cooling air is difficult. This may not be suitable for aircraft application so it is irrelevant.

**4,263,786 Fuel Conserving Air-Conditioning Apparatus and Method for Aircraft**

This invention describes a vapor cycle system sinks heat into the fuel or ram air. The reliance on ram air and fuel cooling limits this system to sub-sonic application. The uniqueness of the subject system (HCS) is that by running the vapor cycle system at relatively high temperature and coupling it to air cycle system allows the sinking of heat into hot fuel heated by aero-thermal effects of high-speed flight..

#### **4,211,093 Vapor Cycle Cooling System**

This invention describes a vapor cycle system using a vane pump. This it is irrelevant to HCS.

#### **4,434,624 Energy-Efficient All-Electric ECS for Aircraft**

This invention is an early version of patent 4,487,034 with the additional evaporator for avionics cooling. The system described in this primarily using ram air to condense the refrigerant thus cool the vapor cycle system and then using the vapor cycle to cool the ram air for cockpit pressurization. When the ram air temperature increases due to high-speed flight, the vapor cycle system could not be cooled by direct ram air. Hence this system design is only for flight that has ram air of total temperature lower than approximately 140 degree F. The simple compressor that used to provide cockpit pressurization would consume very high power and could not help to transfer heat loads.

#### **B64D 13/06 Air Cycle Environmental Control System with Vapor Cycle System Assisted Condensation**

The system described in this invention focused on using the vapor cycle system to assist condensation removal. The interaction between the vapor system and the air cycle system is limited to pre-cooling the bleed air input or bleed air from the compressor so the water condensation can be removed from the air stream. The magnetic coupling described is a non-active coupling device to facilitate a sealed vapor cycle system. The vapor cycle is not a primary heat transfer loop. The system depends on engine bleed air and ram-air cooling.

Using the ram air to cool the engine bleed air is not effective for high-speed flight due to the elevated total temperature.



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Reg. No.: 25.858

Date: 4/11, 2003

<b>INFORMATION DISCLOSURE CITATION</b> <i>(Use several sheets if necessary)</i>				Docket Number (Optional) <b>P212</b>		Application Number <b>UNKNOWN</b>		
				Applicant(s) <b>YUHANG HO</b>				
				Filing Date <b>UNKNOWN</b>		Group Art Unit <b>UNKNOWN</b>		
<b>U.S. PATENT DOCUMENTS</b>								
*EXAMINER INITIAL	REF	DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE	
		4,487,034	12/11/84	M. J. CRONIN, ET AL.	62	402		
		5,545,084	8/13/96	H. FISCHER, ET AL.	454	76		
		4,869,071	9/26/89	J. M. WEHNER, ET AL.	62	133		
		US 6,182,435 BI	2/6/2001	R. E. NIGGEMANN, ET AL.	60	39.02		
		5,058,390	10/22/91	F. L. SINDERMANN, ET AL.	62	181		
		6,041,615	3/28/2000	S. OSTERSETZER, ET AL.	62	402		
		4,263,786	4/28/81	K. G. ENG	62	87		
		4,434,624	3/6/84	M. J. CRONIN, ET AL.	62	172		
		PCT/US/98/14033	1/21/99	M. A. JONQUERES				
<b>FOREIGN PATENT DOCUMENTS</b>								
	REF	DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	Translation	
							YES	NO
<b>OTHER DOCUMENTS</b> <i>(Including Author, Title, Date, Pertinent Pages, Etc.)</i>								
<b>EXAMINER</b>				<b>DATE CONSIDERED</b>				
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